REMARKS

Reconsideration and allowance of the subject application are respectfully solicited.

Claims 1, 3 through 15, and 17 through 40 are pending, with Claims 1, 15, 33, and 35 being independent. Claims 2 and 16 have been cancelled without prejudice. Claims 1, 3 through 5, 7, 9 through 15, 17 through 29, 33, 35, 39 and 40 have been amended. The specification has been amended.

The Official Action required correction of the formal drawings as proposed in the Request for Approval of Drawing Changes filed December 20, 2001. In response, Applicant is respectfully enclosing herewith a Letter Transmitting Corrected Formal Drawings, effecting the drawing corrections set forth in the Request. Favorable consideration is earnestly solicited.

Claims 1 through 11, 15 through 25, and 29 through 40 were rejected under 35 U.S.C. § 102(e) over U.S. Patent No. 6,225,637 (Terashima, et al.). Claims 12, 13, 26, and 27 were rejected under 35 U.S.C. § 103 over Terashima, et al. in view of U.S. Patent No. 4,954,717 (Sakamoto, et al.) Claims 14 and 28 were rejected under 35 U.S.C. § 103 over Terashima, et al. in view of Sakamoto, et al. and U.S. Patent No. 4,469,949 (Mori, et al.). All rejections are respectfully traversed.

Claims 1 and 15 variously recite, inter alia, changing a ratio of currents to be respectively supplied to the first and second magnetic lenses (of the first unit) to move a principal plane of the first unit so that an image distortion of the projection optical system is corrected (with Claim 15 specifying that the change is on the basis of the correction information).

Claim 33 recites, inter alia, that the controller is arranged to control a current to be supplied to the magnetic lens so as to adjust an image distortion of the projection optical system.

Claim 35 recites, inter alia, that a moving amount of the second principal plane is equal to a value obtained by multiplying a moving amount of the first principal plane by a magnification of the projection optical system, and a moving direction of the first principal plane is the opposite direction to that of the second principal plane.

However, Applicant respectfully submits that none of Terashima, et al., Sakamoto, et al., and Mori, et al., even in combination, assuming, arguendo, that the documents could be combined, discloses or suggests at least the above-discussed claimed features as recited, inter alia, in Claims 1, 15, 33, and 35. The Official Action refers, inter alia, with respect to Terashima, et al., to (1) electron lenses 1008, (2) rotation lens 1010 (for rotating a pattern image on the mask 1005 to be projected onto the wafer 1014 (col. 20, lines 4-6)), (3) focus correction lens 1013 (for correcting the focal point of the reduction electron optical system 1008 (col. 20, lines 13 and 14), and (4) the discussion regarding the aberration correction system 7, which constitutes a unipotential lens made up of three electrodes (col. 13, lines 35 through 45). However, Applicant respectfully submits that neither the foregoing nor the remainder of Terashima, et al. (or the other relied upon documents) constitutes either a description or a suggestion of the above-discussed claimed features. Applicant further respectfully submits that there has been no showing of any indication of motivation in the cited documents that would lead one having ordinary skill in the art to arrive at such claimed features.

The dependent claims are also submitted to be patentable because they set forth additional aspects of the present invention and are dependent from independent claims discussed

above. Therefore, separate and individual consideration of each dependent claim is respectfully requested.

Applicant submits that this application is in condition for allowance, and a Notice of Allowance is respectfully requested.

Applicant's undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our address listed below.

Respectfully submitted,

Daniel S Glueck

Attorney for Applicant
Daniel S. Glueck
Registration No. 37,838

FITZPATRICK, CELLA, HARPER & SCINTO
30 Rockefeller Plaza
New York, New York 10112-3801
Facsimile: (212) 218-2200

DSG\dc

DC_MAIN 109020 v 1

VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE SPECIFICATION

The paragraph starting at page 4, line 1 and ending at line 11 has been amended as follows.

In the case of the electron beam projection apparatus described above, the exposure width of one exposure operation is generally several mm to several ten mm. Image distortion and off-axis aberration mainly caused by field curvature of the projection lens become larger than in the conventional apparatus, thus degrading the exposure [patterns] pattern's resolution. In order to prevent degradation in the resolution, the region of the pattern of the mask to be irradiated with the electron beam may be reduced. However, this cannot achieve a great improvement in productivity as compared to the conventional electron beam exposure method.

The paragraph starting at page 16, line 11 and ending at line 18 has been amended as follows.

The charged particle [ptojection] projection system of this embodiment has a charged particle beam source 1, a reduction lens 3, a charged particle shaping aperture 4, a collimator lens 6, and first and second projection lenses 9 and 11. A charged particle beam 2 emerging from the charged particle beam source 1 irradiates a mask 7 placed on a mask stage 8 to transfer a pattern on the mask 7 onto a sample 12 on sample stage 13.

VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE CLAIMS

1. (Twice Amended) A projection apparatus for projecting a pattern formed on a mask held by a mask stage onto a substrate, said projection apparatus comprising:

a charged particle beam source which emits a charged particle beam;

an irradiation system which has a shaping system for shaping the charged particle beam to have an arcuate cross-section and which irradiates the mask with the arcuate cross-sectional charged particle beam;

a projection optical system which projects the pattern onto the substrate, said projection optical system including a first unit having first and second magnetic lenses, and a second unit having a magnetic lens system; and

a controller arranged to change a ratio of currents to be respectively supplied to said first and second magnetic lenses to move a principal plane of said first unit so that an image distortion of said projection optical system is corrected.

3. (Twice Amended) The apparatus according to claim [2] 1, wherein said second unit includes third and fourth magnetic lenses as the magnetic lens system, and

wherein said controller is further arranged to change a ratio of currents respectively supplied to said third and fourth magnetic lenses to move a principal plane of said second unit so as not to change an image position and magnification of said projection optical system when moving the principal plane of said first unit.

4. (Twice Amended) The apparatus according to claim 1, wherein said projection apparatus further comprises an acquisition system which acquires image information indicating a feature of an image projected onto a substrate stage for supporting the substrate by measurement, and

wherein said controller is further arranged to change the ratio of the currents to be respectively supplied to said first and second magnetic lenses so as to correct an image distortion of said projection optical system on the basis of the image information.

5. (Amended) The apparatus according to claim 4, wherein said acquisition system acquires image information containing information indicating a radius of an image formed on [said] the substrate stage with the arcuate cross-sectional charged particle beam emerging from said shaping system.

7. (Amended) The apparatus according to claim 4, wherein said acquisition system acquires image information containing information indicating an image height of an image formed on [said] the substrate stage with the arcuate cross-sectional charged particle beam that has passed through said shaping system.

9. (Twice Amended) The apparatus according to claim 4, wherein said acquisition system comprises (a) an image distortion measurement mask having a transmitting system that passes therethrough a predetermined portion of the arcuate cross-sectional charged

particle beam, said mask being held by said mask stage during measurement, and (b) a measurement unit for measuring coordinates of a position where the charged particle beam that has passed through said transmitting system becomes incident on [said] the substrate stage, and

wherein said acquisition system calculates image information indicating a feature of an image projected onto [said] the substrate stage on the basis of the measured coordinates.

10. (Amended) The apparatus according to claim 9, wherein said image distortion measurement mask has a plurality of transmitting systems arranged arcuatedly, and

wherein said measurement unit measures coordinates of respective positions where charged particle beams that have passed through said transmitting systems become incident on [said] the substrate stage.

11. (Twice Amended) The apparatus according to claim 10, wherein said acquisition system calculates a radius of an image projected onto [said] the substrate stage on the basis of a plurality of measured coordinates, and

wherein said controller is further arranged to change the ratio of the currents to be respectively supplied to said first and second magnetic lenses, so that a radius obtained by measurement coincides with a theoretical radius obtained when said projection optical system has no aberration.

12. (Twice Amended) The apparatus according to claim 9, wherein said acquisition system further comprises a substrate having a mark, [said] <u>the</u> substrate being placed on [said] <u>the</u> substrate stage during measurement, and

<u>wherein</u> said measurement unit detects backscatter electrons from [said] <u>the</u> substrate, thereby measuring coordinates of a position where the charged particle beam that has passed through said transmitting system becomes incident on [said] <u>the</u> substrate stage.

13. (Amended) The apparatus according to claim 12, wherein measurement of the coordinates of the incident position is performed while moving [said] <u>the</u> substrate stage such that the mark moves across the position where the charged particle beam that has passed through said transmitting system becomes incident on [said] <u>the</u> substrate stage.

14. (Amended) The apparatus according to claim 13, wherein [said] <u>the</u> mark is a crisscross mark made of a heavy metal.

15. (Twice Amended) A control method for a projection apparatus having a mask stage for holding a mask, a charged particle beam source which emits a charged particle beam, an irradiation system which has a shaping system for shaping the charged particle beam to have an arcuate cross-section and <u>which</u> irradiates the mask with the arcuate cross-sectional charged particle beam, and a projection optical system which projects the pattern onto a

substrate, [said] the projection optical system including (a) a first unit having first and second magnetic lenses[,] and (b) a second unit having a magnetic lens system, said method comprising:

[the] an acquisition step of acquiring correction information necessary for correcting aberrations of [said] the projection optical system; and

[the] a control step of changing a ratio of currents to be respectively supplied to [said] the first and second magnetic lenses, on the basis of the correction information, to move a principal plane of [said] the first unit so that an image distortion of the projection optical system is corrected.

17. (Twice Amended) The method according to claim [16] 15, wherein [said] the second unit has third and fourth magnetic lenses as the magnetic lens system, and

wherein [the] said control step comprises changing a ratio of currents respectively supplied to [said] the third and fourth magnetic lenses to move a principal plane of [said] the second unit so as not to change an image position and magnification of [said] the projection optical system when moving the principal plane of [said] the first unit.

18. (Twice Amended) The method according to claim 15, wherein [the] said acquisition step includes the measurement step of acquiring by measurement image information indicating a feature of an image projected onto a substrate stage for supporting the substrate as the correction information, and

<u>wherein</u> [the] <u>said</u> control step comprises correcting an image distortion of [said] <u>the</u> projection optical system on the basis of the image information.

19. (Amended) The method according to claim 18, wherein [the] <u>said</u> acquisition step comprises the step of acquiring image information containing information indicating a radius of an image formed on [said] <u>the</u> substrate stage with the arcuate cross-sectional charged particle beam emerging from [said] <u>the</u> shaping system.

20. (Amended) The method according to claim 19, wherein [the] <u>said</u> control step comprises controlling the ratio of the currents to be respectively supplied to [said] <u>the</u> first and second magnetic lenses, so that the measured radius coincides with a theoretical radius obtained when [said] <u>the</u> projection optical system has no aberration.

21. (Amended) The method according to claim 18, wherein [the] <u>said</u> acquisition step comprises the step of acquiring image information containing information indicating an image height of an image formed on [said] <u>the</u> substrate stage with the arcuate cross-sectional charged particle beam that has passed through [said] <u>the</u> shaping system.

22. (Amended) The method according to claim 21, wherein [the] <u>said</u> control step comprises changing the ratio of the currents to be respectively supplied to [said] <u>the</u> first and

second magnetic lenses, so that the actually measured image height coincides with a theoretical image height obtained when [said] the projection optical system has no aberration.

23. (Twice Amended) The method according to claim 15, wherein said acquisition step comprises (a) [the] a preparation step of causing [said] the mask stage to hold an image distortion measurement mask having a transmitting system that passes therethrough a predetermined portion of the arcuate cross-sectional charged particle beam, (b) [the] a measurement step of measuring coordinates of a position where the charged particle beam that has passed through [said] the transmitting system becomes incident on a substrate stage for supporting the substrate, and (c) [the] a calculation step of calculating, as correction information necessary for correcting an image distortion of [said] the projection optical system, image information indicating a feature of an image projected onto [said] the substrate stage on the basis of the measured coordinates, and

wherein [the] said control step comprises changing the ratio of the currents to be respectively supplied to [said] the first and second magnetic lenses to move a principal plane of [said] the first unit so as to correct an image distortion of [said] the projection optical system on the basis of the correction information.

24. (Amended) The method according to claim 23, wherein [said] the image distortion measurement mask has a plurality of transmitting systems arranged arcuately, and

wherein the measurement step comprises measuring coordinates of respective positions where charged particle beams that have passed through [said] the transmitting systems become incident on [said] the substrate stage.

25. (Twice Amended) The method according to claim 24, wherein [the] said calculation step in the acquisition step comprises calculating a radius of an image projected onto [said] the substrate stage on the basis of a plurality of measured coordinates, and

wherein [the] said control step comprises changing the ratio of the currents to be respectively supplied to [said] the first and second magnetic lenses, so that a radius obtained by measurement coincides with a theoretical radius obtained when [said] the projection optical system has no aberration.

26. (Amended) The method according to claim 23, wherein [the] said acquisition step further comprises the step of placing a substrate having a mark on [said] the substrate stage before measurement, and

wherein [the] said measurement step in [the] said acquisition step comprises detecting backscatter electrons from [said] the substrate, thereby measuring coordinates of a position where the charged particle beam that has passed through [said] the transmitting system becomes incident on [said] the substrate stage.

27. (Amended) The method according to claim 26, wherein [the] <u>said</u> measurement step comprises measuring the coordinates of the incident position while moving [said] <u>the</u> substrate stage such that the mark moves across the position where the charged particle beam that has passed through [said] <u>the</u> transmitting system becomes incident on [said] <u>the</u> sample stage.

28. (Amended) The method according to claim 27, wherein [said] <u>the</u> mark is a crisscross mark made of a heavy metal.

29. (Amended) A method of manufacturing a device, comprising the steps of:

fixing a mask on [said] <u>the</u> mask stage of [said] <u>the</u> projection apparatus according to claim 1;

placing a substrate on a substrate stage of [said] <u>the</u> projection apparatus; and

transferring a pattern formed on the mask onto the substrate.

33. (Amended) A projection apparatus for projecting a pattern formed on a mask onto a substrate, <u>said projection apparatus</u> comprising:

an irridation system which irradiates the mask with a charged particle beam emerging from a charged particle beam source;

a projection optical system which has a magnetic lens and <u>which</u> projects the pattern onto the substrate; and

a controller arranged to control a current to be supplied to said magnetic lens so as to adjust an image distortion of said projection optical system.

35. (Amended) A projection apparatus for projecting a pattern formed on a mask onto a substrate, said projection apparatus comprising:

an irradiation system which irradiates the mask with a charged particle beam emerging from a charged particle beam source;

a projection optical system which projects the pattern onto the substrate, said projection optical system including (a) a first unit having first and second magnetic lenses and (b) a second unit having third and fourth magnetic lenses; and

a controller arranged to change a ratio of currents to be respectively supplied to said first and second magnetic lenses to move a first principal plane of said first unit and to change a ratio of currents to be respectively supplied to said third and fourth magnetic lenses to move a second principal plane of said second unit,

wherein a moving amount of the second principal plane is equal to a value obtained by multiplying a moving amount of the first principal plane by a magnification of said projection optical system, and a moving direction of the first principal plane is the opposite direction to that of the second principal plane.

39. (Amended) A method of manufacturing a device, said method comprising the steps of:

transferring a circuit pattern onto a substrate using [said] the projection apparatus of claim 33; and

developing the resultant substrate.

40. (Amended) A method of manufacturing a device, said method comprising the steps of:

transferring a circuit pattern onto a substrate using [said] the projection apparatus of claim 35; and

developing the resultant substrate.

DC_MAIN 115717 v 1